A Tale of Two Premiums—Examining Bids From a Multiple Round Vickrey Auction with Differing Information Sets

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Abstract

Two definitions of willingness-to-pay derived from a Vickrey auction with multi-product and multiple rounds with different information sets are examined. These definitions are examined in the context of valuing pork products with embedded environmental attributes and we show how information can have adverse effects on a base product of comparison.

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Introduction

Since the early 1990's, many consumer studies have used experimental economics to obtain what people would pay for certain attributes related to products. These studies have elicited values from consumers related to food safety attributes (Fox, 1994; Fox et al., 1995; Fox et al., 1996; Hayes et al. 1996; Roosen et al., 1998), quality differences in food products (Melton et al. 1996a, 1996b; Umberger et al., 2001), and even how packaging affects the value of a product (Hoffman et al. 1993; Menkhaus et al. 1992). All of the experiments used in these studies have extracted consumer's willingness-to-pay (WTP) by employing the use of a second price sealed-bid auction, also known as a Vickrey auction.

In many of these auction studies the researchers have endowed a consumer with a product that has certain attributes and ask them to bid for a product with a new set of attributes (Roosen et al. 1998, Shogren et al., 1994b, Fox et al., 1994). The value derived from this can be considered the consumer's willingness to pay for the new set of attributes. By endowing the participant's in their studies with the product and asking them to give their willingness to pay for the new attributes, the researchers of these studies have assumed that the new good with the new set of attributes has a negligible effect or the effect is not important on the endowed good. We would argue that it is not only the premium or WTP for the attribute that is important, but also the effect the information released has on the endowed product. This in itself can be viewed as a type of premium. Hence, while the premium observed for the new set of attributes may be positive, this positive premium may be due to the consumer devaluing the endowed good. If consumers' WTP is only coming from the devaluation of the endowed good, then the premium for the new set of attributes is not necessarily a sign of value added.

There are two objectives of this paper. The first objective is to present a theoretical model for examining multiple products in a multi-round Vickrey auction with potentially different information sets in each round. From this model we are able to define two WTP values. One of the willingness to pay values from our model is the one used in the experiments mentioned above. The other willingness to pay definition shows the effect that the information has on the base product of comparison. Using the model it can be argued that one of the definitions is comparable to a short-run value that may be seen in a market initially and the other is a long-run WTP.

The second objective of this paper is to present results of the two WTP measures from an experiment done in six cities across the U.S. to value pork products with embedded environmental attributes. Two definitions of WTP derived from a Vickrey auction with multi-product and multiple rounds with different information sets are examined. These definitions are examined in the context of valuing pork products with embedded environmental attributes. We show that when environmental information is released to the consumer about the product it has an adverse effect on the product of comparison.

Theoretical Base for Modeling Consumer Behavior with Differing Information Sets

Teisl et al. studied what effects dolphin-safe labeling had on the tuna industry (1999). To study this issue, they adopted a model proposed by Foster and Just (1989) that takes into account when consumers have different information sets about the product. Their model uses the following indirect utility function:

(1) $V^s = V(\mathbf{A}^S, \mathbf{q}, Y, \mathbf{p})$.

The term $\mathbf{A}^S$ is defined as the environmental assessments for m products given information set S, $\mathbf{q}$ is a vector of other quality characteristics, Y is income, and $\mathbf{p}$ is a vector of prices for the m products. They assume that this function increases with quality characteristics and income, and decreases with prices.

To translate environmental information into an environmental assessment $\mathbf{A}^S$, Teisl et al. assume that the assessment function can be modeled as a household production process. This process takes into account the individual's environmental knowledge, cognitive abilities, time, and the environmental information presented at the time of purchase. They model this as:

(2) $A^S_j = f(S_j, G, t_j; \theta)$.

In this process, A^s_j is the individual's subjective environmental assessment of purchasing good j given information set S. S_j is the environmental information displayed about product j at the time of purchase. The consumer's prior stock of environmental information is represented by G. This would include any news accounts, advertising, word-of-mouth, or any other source of information previously obtained about the product. The time spent analyzing the environmental information about product j is denoted by t_j. Finally, θ represents the objective levels of environmental impact from consumption of the products.

Consumer Behavior in a Multiple Round Vickrey Auction with Different Information

The standard utility maximization problem assumes that prices are fixed and consumers choose the quantity they want to consume. While this is the usual model for consumer's decision, it is not indicative of how consumers make decisions in a multiple round second-price sealed-bid auction. In this auction setting, the consumers have a fixed quantity to consume and are allowed to submit bids. These consumers will set bids for the objects they are bidding upon at their true valuation for that product when there are no embedded environmental attributes and v_{i12}, which is defined as the value of the physical attributes plus the value of any warm-glow giving, when environmental attributes exist.[2] This is the unique behavioral characteristic associated with the second-price auction. Another characteristic of this model is that different information sets can be used in the different rounds of bidding.

The utility function of a consumer can be modeled as having two different components. The first component relates to the products that will be consumed and how they show up in the utility function. The second component within the utility function is an assessment function that maps certain attributes of the products into utility. Hence the consumer's utility function for a given information set **I** is represented as:

(3) $U = U(\mathbf{y}, x_1, x_2; \mathbf{A}^{\mathbf{I}})$.

The term **y** is defined as a vector of goods not in the auction, x_1 is a non-environmental product in the auction, x_2 is an environmental product in the auction, and $\mathbf{A}^{\mathbf{I}}$ is the environmental assessments for x_1 and x_2 given information set **I**. It is assumed that the consumer's utility function is increasing at a decreasing rate for **y**, x_1, x_2, and any element of $\mathbf{A}^{\mathbf{I}}$.

It is assumed that the consumer's utility is dependent on the characteristics of purchased goods. Further assume that these goods can be broken up into three groups. The first group is the normal basket of goods that the consumer purchases outside of the auction setting. This basket of goods is denoted by **y** and has an associated vector of fixed prices $\mathbf{p_y}$. The second group of goods is the set of products in the auction that have no environmental attributes, while the third group of goods is the set of products in the auction that have embedded environmental attributes. The only differences between these last two groups are that they differ in the level of embedded environmental attributes and possibly perceived visual quality attributes. Without loss

[2] See Hurley and Kliebenstein for a discussion on how to interpret bids in a Vickrey Auction when the good being auctioned has public good attributes (2003). To understand warm-glow giving see Andreoni (1988, 1990).

of generality, it is assumed that the last two groups of goods only consist of one product each.[3] The non-environmental product will be denoted by x_1 and the product with embedded environmental attribute(s) will be denoted by x_2. In this setting, the choice variables for the consumer are the normal basket of goods **y**, the bid for the typical product p_1, and the bid for the product with embedded environmental attribute(s) p_2.

Following Teisl et al. (1999), it is assumed that within the consumer's utility function there is an assessment function $\mathbf{A}^{\mathbf{I}}$ which evaluates the products based on a set of characteristics given an information set **I**. This assessment function contains the assessment of each product, i.e., $\mathbf{A}^{\mathbf{I}} = [A_1^I, A_2^I, \ldots, A_n^I]$ where A_n^I is the assessment of product n based on information set **I**. This assessment function maps certain attributes such as quality characteristics into utility. Within this information set **I**, there is information pertaining to the attributes embodied within the products and previous market prices. In the case of an auction for products with embedded environmental attributes, one information set may contain no environmental information regarding the products. This shall be known as the naïve information set. In another information set, there could be environmental information released.

The set of characteristics in the assessment function can be divided into two subsets. The first subset is related to the physical attributes related to the products and will be denoted by **Q**. These characteristics are associated with visual quality—color, texture, marbling, etc. Within this **Q**, the evaluation of each product can be divided by product, i.e., $\mathbf{Q} = [Q_1, Q_2, \ldots, Q_n]$ where Q_n is the quality evaluation of product n based on visual inspection. It is assumed that the utility function is increasing in **Q**, i.e., a consumer has an ordered preference for different visual

[3] For the second group, there is usually only one product in that set which is used as a basis for comparison. For the third group of products, there will be independence between the products that have different environmental attributes. This independence will come from the fact that in this auction at most one product will be sold after all the rounds of bidding are completed. Hence, by adding products to this group there will be no affect on the budget constraint of the consumer.

attributes. Across information sets, these visual attributes are constant for each product. The visual quality of a product does not change across information sets. Due to the constant visual quality, no adjustments will need to be made when comparing products across information sets. Within a particular information set, these visual qualities can be very different across products or at least perceived as such. This would imply that any comparison of products within an information set must account for possible perceived visual quality differences.

The other subset of characteristics is related to environmental attributes and will be denoted by **E(I)**. Within **E(I)**, the evaluation of each product can be segregated by product, i.e., **E(I)** = $[E_1(I), E_2(I), \ldots, E_n(I)]$ where $E_n(I)$ is the quality evaluation of product n based on perceived or expected environmental attributes given information set I. It is assumed that the utility function is increasing in both the level of environmental attributes and the number of environmental attributes. A consumer's utility will increase if they perceive that the number of environmental attributes has increased or if the level of a particular environmental attribute is perceived to increase. These characteristics are related to the perceived or expected environmental attributes embodied in each product. Whether these characteristics are perceived versus expected will depend upon which information set the consumer has. In the naïve round, this set of characteristics would be related to the consumer's expectation of the environmental attributes embodied in each product. In a round where environmental information exists for each product, then the set of characteristics are perceived.

For each purchase decision, the consumer will maximize her utility function given a fixed amount of income M under the given rules of the second-price auction. Adapting the model of Teisl et al. (1999) to this situation, the consumer’s indirect utility function can be represented as:

(4) $$V^I = V(\mathbf{A}^I, M, \mathbf{p_y})$$

where $\mathbf{A^I} = f(\mathbf{Q}, \mathbf{E(I)})$.

From this indirect utility function, a person's true valuation v_i can be derived through examining what happens to a person's utility when a new allocation of attributes or a new information set is provided. A person's true valuation can be defined as the maximum amount of income she would be willing to pay to obtain a change. In this case, it would be the amount of money the consumer would be willing to give up to obtain the environmental attributes or the information pertaining to the environmental attributes.

Since a person's true valuation of a particular change is dependent on the indirect utility function, this would imply that a person's true valuation is dependent on the same exogenous factors. In this case, a person's true valuation depends on the assessment function, the information set, income, and the prices of other goods. Taking this a step further, since it has been shown that a person's bid in an auction setting is dependent on a person's true valuation, this would imply that the exogenous factors of a person's true valuation would also be influencing factors in a person's bid function. With this information, WTP in a multiple round second-price auction with different information sets can now be defined.

Defining Willingness-to-Pay

This paper examines two WTP measures. To see where these different measures come from, an examination of the bids given in each round of the second-price auction is necessary. Within this auction, the participants will buy no more than one of the goods being auctioned, i.e., a characteristic of this model is that only one product will be sold after the auction is over. The product sold is randomly selected from a round that is also randomly selected. This allows an auction that investigates the value of multiple goods to maintain the properties of the Vickrey auction with a single good.

Without loss of generality, it is assumed that there are two products being bid upon. The first product is one that has no embedded environmental attributes, while the second product is a product that has the same physical attributes as the first product but has embedded environmental attributes. In the naïve bidding round where there is no specific environmental information about the two products, the bidders only have expectations about the embedded environmental attributes. In the round with environmental information, the bidders know the embedded environmental attributes. The bids for the first and second product are defined respectively as $b_1(\mathbf{p_y}, M, \mathbf{A^I})$ and $b_2(\mathbf{p_y}, M, \mathbf{A^I})$. These bids are a function of the person's true valuation for each product.[4] In a second-price auction setting, it can be expected that $b_1(\mathbf{p_y}, M, \mathbf{A^I})$ and $b_2(\mathbf{p_y}, M, \mathbf{A^I})$ will be different across different information rounds if participants value environmental attributes.

To make this analysis clearer, assume that there are two information rounds in the second price auction. In the first round, it is assumed that there is no specific information **I'** related to the environmental attributes. This is known as a naïve bidding round where consumers usually bid on visual attributes. For the next round, information **I''** is released on the embedded environmental attributes of the product. This would imply that under the first information set **I'**, the set of bids are $b_1(\mathbf{p_y}, M, \mathbf{A^{I'}})$ and $b_2(\mathbf{p_y}, M, \mathbf{A^{I'}})$.[5] Under the second information set **I''**, the set of bids are $b_1(\mathbf{p_y}, M, \mathbf{A^{I''}})$ and $b_2(\mathbf{p_y}, M, \mathbf{A^{I''}})$. It is obvious that the prices for the goods outside of the experiment $\mathbf{p_y}$, and consumer income M of the consumer have not changed. Hence, the only thing that has changed is the information in the assessment function.

[4] Since it is assumed that each bid is derived from the second-price auction, $b_i(\mathbf{p_y}, M, \mathbf{A^I})$ will be equal to the value of the attributes plus the value of the warm glow effect from giving to a public good if the bidders are strategically optimizing their payoff. See Hurley and Kliebenstein for a further explanation (2003). When the bidder expects or knows that the product has no environmental attributes, her bid for that product will equal her true valuation.

[5] Note that in the naïve round, the participant has no environmental information regarding the products. Hence, the subscripts on prices are only being used to keep track of each product through the different rounds.

The assessment function can be written as $\mathbf{A^I} = f(\mathbf{Q}, \mathbf{E(I)})$. Since there are only two products being examined, this function can be written as $\mathbf{A^I} = f(Q_1, Q_2, E_1(\mathbf{I}), E_2(\mathbf{I}))$. In this case, Q_1 and Q_2 denote the visual quality assessment of the typical package and the environmental package respectively. No matter which information set the consumer is in, these quality attributes do not differ across information sets for each product. Within a particular information set, these quality evaluations can be quite different. $E_1(\mathbf{I})$ and $E_2(\mathbf{I})$ denote the perceived or expected environmental attributes in the typical package and the environmental package in information set **I**. In the naïve information set **I'** where no information related to environmental attributes has been released, these environmental quality assessments are based on expectations. Within this information set, there is no way for the researcher to know the basis for the expectation. In the environmental information set **I''**, the consumer knows the level and number of environmental attributes embedded in each product. They also know that the product with environmental attributes is using the typical product as the basis, i.e., a comparison is made between the two products within this information set where the typical product is used as the basis of comparison.

The bids given in the auction represent all of the attributes incorporated in the products being auctioned, i.e., the bids represent both the visual quality attributes and the environmental attributes. The objective of this paper is to value the environmental attributes only. To do this, the visual quality attributes must be factored out. This implies that there are two major definitions for WTP that can be developed from this auction setting with different information sets to obtain the value for environmental attributes. The first definition for WTP that arises is related to comparing bids across information sets. This measure is called the consumer's WTP with unknown ex ante expectations. It examines the bid differential for the product due to the release of information. In this case, WTP for any embedded environmental attributes in product i due to the information provided (WTP_i) can be defined as:

$$(5) \qquad WTP_i = b_i(\mathbf{p_y}, M, \mathbf{A}^{\mathbf{I}''}) - b_i(\mathbf{p_y}, M, \mathbf{A}^{\mathbf{I}'})$$

$$= b_i(\mathbf{p_y}, M, f(Q_1, Q_2, E_1(\mathbf{I}''), E_2(\mathbf{I}''))) - b_i(\mathbf{p_y}, M, f(Q_1, Q_2, E_1(\mathbf{I}'), E_2(\mathbf{I}')))$$

$$= WTP_i(\mathbf{p_y}, M, Q_i, E_i(\mathbf{I}''), E_j(\mathbf{I}''), E_i(\mathbf{I}'), E_j(\mathbf{I}'))\ ^{6},$$

for i,j = 1 or 2. This measure represents the consumer's WTP for environmental attributes related to product i.[7] Since Q_i is the same across both information sets, an advantage of this measure is that no adjustment is needed for visual quality differences in the product. A major problem with this measure is that the attributes of $E_i(\mathbf{I}')$ are unknown to the researcher because it is based on the expectation of the consumer. There is no way of knowing ex ante what the consumer's expectations are for each product in the naïve round.

The benefit of this measure is that it gives an ex post view of the consumer's expectations. If it is positive, this would imply that the consumer's expectations on a particular product were lower than the actual environmental attributes embedded in the product. Zero implies that the consumer's expectations from the naïve round are met in the round with environmental information. Finally, a negative value implies that the consumer had a higher expectation of what attributes were in the product than what actually were. Another way of viewing this measure is to think of it as the short-term effect when environmental information is released into the market. It is the initial gain or loss before the market has time to react and the consumer can change her spending habits. This measure also gives a producer a more accurate picture of the initial gains to be made by selling a product that has environmental attributes.

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[6] The visual quality Q_j for product $j \neq i$ can be dropped because it is assumed to have no effect on the price of product i.

[7] This is not the value of the new information set as a whole. This represents the value of the information related to product i. To obtain the value of the information set as a whole, WTP_i would be summed over all i. In this case $WTP_1 + WTP_2$ equals the consumer's willingness-to-pay for the new information set.

The second definition of WTP looks at the premium a consumer will pay for a product with embedded environmental attributes as compared to a basis product within the same information set. In this case, this product is the typical product. This measure is known as the consumer's WTP for environmental attributes with a known basis. Hence, this definition of WTP can be represented as:

$$(6) \qquad WTP = b_2(\mathbf{p_y}, M, \mathbf{A}^{\mathbf{I}''}) - b_1(\mathbf{p_y}, M, \mathbf{A}^{\mathbf{I}''})$$

$$= b_2(\mathbf{p_y}, M, f(Q_2, E_1(\mathbf{I''}), E_2(\mathbf{I''}))) - b_1(\mathbf{p_y}, M, f(Q_1, E_1(\mathbf{I''}), E_2(\mathbf{I''})))$$

$$= WTP(\mathbf{p_y}, M, Q_1, Q_2, E_1(\mathbf{I''}), E_2(\mathbf{I''})).$$

Assuming Q_1 equals Q_2, i.e., each product has the same visual qualities, this measure represents the consumer's WTP for a product with embedded environmental attributes over a typical product. This can be viewed as a long-term measure where the consumer has information related to environmental attributes and is allowed to adjust her market decisions.

The advantage of this definition is that the consumer knows the environmental attributes within each product where one of the products is being used as the basis of comparison. $E_1(\mathbf{I''})$ and $E_2(\mathbf{I''})$ are known to the researcher as well as the consumer. The major disadvantage of this definition is that it must assume that the visual quality attribute across products is the same. This is usually not the case. If possible, this measure will need to be adjusted for the perceived visual quality differences. One way to adjust for the visual quality difference is to take the difference of the two products in the naïve round and use it to adjust the WTP appropriately. This of course assumes that the expectation of embedded environmental attributes for each product in the naïve round are equal. Hence, the second WTP measure adjusted for visual quality differences can be represented as:

$$(7) \qquad WTP = WTP(\mathbf{p_y}, M, Q_1, Q_2, E_1(\mathbf{I''}), E_2(\mathbf{I''})) - (b_2(\mathbf{I'}) - b_1(\mathbf{I'}))$$

where $b_i(\mathbf{I'}) = b_i(\mathbf{p_y}, M, \mathbf{A^{I'}})$ for i = 1, 2.

If $b_1(\mathbf{I'})$ is greater than $b_2(\mathbf{I'})$, this would imply that the participant viewed the first product having a better visual appeal than the second product. In this case, there would be a positive adjustment to WTP compared to equation 6.

Study Design and Data

The auction method used was a second-priced sealed-bid auction segmented into five bidding rounds. A preliminary auction to sell candy bars was used to familiarize the participants with the second price auction. After this first auction was completed, a multiple trial second price auction with the pork products was conducted. In the first three rounds, participants bid only on the physical attributes of the product having no other information except for the previous round's bids. This allowed participants to become familiar with the auction process and obtain feedback on price information. In the fourth round, the participants were informed of the specific environmental attributes associated with the respective products. This release of information allowed for determining what the effect of releasing environmental information had on participants' bids. In the fifth round, the implications of the environmental attributes were further explained and the participants were allowed to bid a final time. Following Fox et al. (1995, 1996), we controlled for wealth effects[8] by randomly choosing at the end of the experiment both one round and one product from that selected round to be the product sold.

The products used to elicit bids were two-pound packages of uniformly cut, boneless, 1¼ inch pork loin chops. These packages were developed to look as uniform as possible. This implies that bid responses should reflect the value of the environmental attribute. The participants were allowed simultaneously to bid on ten different packages of pork chops each

[8] Wealth effects are when participants change their bids because they won an earlier trial (Fox et al., 1995). See Davis and Holt for a discussion of wealth effects in experimental markets.

having different environmental attributes. The packages of pork chops were arranged in a row, and placed on ice in one of three white coolers. Each of the packages were labeled as Package i, where i = 1,.., 10. After the third round each participant was told that one package was a "typical package" with no particular environmental attributes. In this same round, the other nine packages were assigned varying levels of environmental attributes pertaining to ground water, surface water, and odor. Odor reduction was at two levels: a 30-40 percent reduction, and an 80-90 percent reduction over the "typical" product. Ground water and surface water impacts were also available at two levels: a 15-25 percent reduction and a 40-50 percent reduction over the "typical" product. Packages were provided with single attributes (only air, ground water, or surface water), double attributes, or all three attributes embedded. The double and triple attribute pork packages were all at the high reduction levels.

Experiments were conducted in six different areas of the United States: Ames, Iowa; Iowa Falls, Iowa; Manhattan, Kansas; Raleigh, North Carolina; Burlington, Vermont; and Corvallis, Oregon. Three experiments were conducted at each site, where each experiment lasted about two hours. Experiments were conducted at 9:00 a.m., 11:30 a.m., and 2:00 p.m. To control for bias in package labeling, corresponding package number were switched with the assigned environmental attribute for each of the different time slots. A random sample of individuals from the area being studied was used to obtain participants for the study. This sample was obtained by a random computer generated sample drawn from telephone numbers in the respective local telephone directory. Each participant was paid forty dollars for participating in the experiment.

Results

In a paper by Hurley and Kliebenstein, a model was presented to explain how to interpret bids from a second-price sealed-bid auction when embedded environmental attributes are present (2003). It was shown that when embedded environmental attributes exist and if the consumer has free-riding tendencies, she only reveals the part of her true valuation she could not receive from another bidder providing the environmental attributes.

Of the 333 participants in the study, results from 329 were usable.[9] Information provided in Table 1 shows the distribution of participants by study region. The experiments were conducted during the summer 1997 through summer 1998 time periods. The number of participants ranged from sixty for the Corvallis, Oregon and Manhattan, Kansas locations to twenty-seven for Burlington, Vermont. In Iowa, the Ames location had forty-nine participants while the Iowa Falls location had fifty-eight participants. Two experiments were conducted in the Raleigh, North Carolina.

Table 1: Number of Participants by Area

Experiment Area	Number of Participants
All areas	329
Ames, IA	49
Manhattan, KS	60
Raleigh, NC (6/28/97)	31
Burlington, VT	27
Iowa Falls, IA	58
Corvallis, OR	60
Raleigh, NC (6/27/98)	44

Table 2 provides a summary of the average bids for each product during each round. It also provides the t-statistic related to the hypothesis test that the average bid from the current round is equal to the average bid in the previous round for the same product. For round one, the highest average bid for the group of pork chops was $3.47 for the package which was later

[9] Four participants were omitted because they did not finish the experiment and surveys. One person had to leave during the study because she was ill. The other three did not complete the survey for unknown reasons.

identified with the low-level odor reduction attribute (thirty to forty percent odor reduction). The lowest average bid in round one was $3.21 for the package aligned with low-level ground water improvement (fifteen to twenty-five percent reduction in the impact to ground water). When testing the hypothesis that these two means are equal, a sample t-statistic of 1.60 is calculated. This implies that the null hypothesis cannot be rejected at the five-percent level of significance.

Table 2: Average Bid for Each Product by Bid Round (All Participants)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	**Average Bids($)**				
	No Environmental Information			**Environmental Information**	
	Round 1	**Round 2**	**Round 3**	**Round 4**	**Round 5**
No Particular Environmental Attributes (Typical)	3.35	3.91 (3.32)	4.13 (1.28)	3.61 (-2.96)	3.57 (-0.22)
Odor 30-40%	3.47	4.01 (3.37)	4.26 (1.57)	3.87 (-2.41)	3.90 (0.16)
Odor 80-90%	3.22	3.81 (3.49)	4.05 (1.45)	3.92 (-0.77)	3.91 (-0.04)
Ground water 15-25%	3.21	3.72 (3.00)	3.91 (1.13)	3.85 (-0.33)	3.86 (0.03)
Ground water 40-50%	3.25	3.84 (3.61)	4.03 (1.18)	3.94 (-0.50)	4.00 (0.36)
Surface Water 15-25%	3.43	4.00 (3.27)	4.15 (0.87)	3.99 (-0.93)	4.05 (0.34)
Surface Water 40-50%	3.26	3.82 (3.38)	4.06 (1.43)	4.10 (0.23)	4.12 (0.14)
Odor 80-90%/Ground Water 40-50%	3.43	4.10 (3.94)	4.25 (0.88)	4.56 (1.77)	4.68 (0.65)
Odor 80-90%/Surface Water 40-50%	3.45	4.08 (3.53)	4.17 (0.52)	4.58 (2.22)	4.66 (0.37)
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	3.46	4.06 (3.28)	4.19 (0.67)	5.13 (5.00)	5.17 (0.23)

Note: The number in parenthesis is the t-statistic for the test of whether the average bid in the current round is equal to the average bid in the previous round.

Examining the average bids in round two compared to round one, it appears that all the average bids by product increased significantly at the five percent level. In round three, there were further increases in the aggregate bids of all the bids, but not by a significant amount at the five-percent level. The difference between the average high and low bid in round three is only $0.35. This would reflect the participant perception of the visual quality of the packages and did not represent a significant difference. When the environmental information was released, some bids significantly increased, some bids stayed statistically the same, and some bids statistically decreased. Another set of information was provided to the participants in round five. This information was related to more detailed environmental and societal health impacts of the environmental attributes. Comparing round four to round five bids showed that there were only minor movements in the bids for each product, which are not significantly different at the five-percent level.

Willingness-to-pay with Unknown Ex Ante Expectations

Two premium measures were developed from the theoretical model above. One of the premiums was known as the consumer's WTP for embedded environmental attributes with a known basis. This definition derived consumer's WTP by taking the difference of a base product with a product that has some level of embedded environmental improvements over the base product in the environmental information round, round four. In this case, the advantage of this definition is that it assures that the visual characteristics of the product are identical.

Table 3 presents an examination of the changes in average bids from round three, the no information round, to round four, the environmental information round. For the entire group, the average bid increase for the most environmental two-pound package of pork loin chops was $0.94, while the bid for what was the typical package decreased by $0.52. The bids in the no information round are much tighter than the bids in the round with environmental information. For the three most environmental packages, the double (t-statistic of 4.81 for the product related to odor and ground water and a t-statistic of 5.91 related to the product with odor and surface water attributes) and triple attribute (t-statistic of 11.17) packages, the bid increases were significantly different from zero at the 0.001 significance level. For the typical (t-statistic of -6.90) and low-level odor reduction (t-statistic of -5.67) packages, there was a significant price decrease at the 0.001 significance level. All other bid changes were not significantly different at the 0.001 level. When relaxing the significance level to five-percent, the bid decreases for the packages with the high-level reduction in odor (t-statistic of -2.15) and the low-level reduction in impact to surface water (t-statistic of -2.53) were also significantly different from zero.

Table 3: Willingness-to-Pay with Unknown Ex Ante Expectations (All Participants)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	**Average Bids($)** **Willingness-to-Pay with Unknown Ex Ante Expectations***
No Particular Environmental Attributes (Typical)	**-0.52**[a] (-6.90)
Odor 30-40%	**-0.39**[a] (-5.67)
Odor 80-90%	*-0.13*[b] (-2.15)
Ground water 15-25%	-0.06[b,c] (-0.89)
Ground water 40-50%	-0.09[b,c,d] (-1.30)
Surface Water 15-25%	*-0.16*[b,c,d] (-2.53)
Surface Water 40-50%	0.04[b,c,d] (0.62)
Odor 80-90%/Ground Water 40-50%	**0.31**[e] (4.81)
Odor 80-90%/Surface Water 40-50%	**0.41**[e] (5.91)
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	**0.94** (11.17)

* The number in parenthesis is the t-statistic for the test of whether the average bid is different from zero. Corresponding letters indicate that at the five-percent level of significance the null hypothesis of the two bid changes were equal could not be rejected. Also, note that the bold and italic changes represent a significant difference from zero at the 0.001 and 0.05 level respectively.

Table 3 also shows when a pairwise comparison was done, which bid changes are not significantly different from each other. When comparing the typical package with the low-level odor reduction impact package, the decreases in average bids for both are not significantly different at the five-percent level. This also holds true for the pairwise comparison between the change in bids of the two double high-level attribute packages. Pairwise comparisons of the change in bids of the low-level and high-level single attribute products also shows that the change in value of many of these products is not significantly different from each other.

Assuming that environmental attributes are not perceived as negative attributes, and since all the pork packages are physically the same good from round three to round four, the expectation for bidding was that the packages would either increase in value or stay the same. This was not the case. Six of the ten products decreased in value, some by significant amounts as demonstrated above. It was not expected that the typical package, as well as some of the single-level attribute packages, would significantly decrease in value.

This effect to the typical package might be explained by a framing bias that is commonly seen in CVM studies. A framing bias occurs when values are affected by the method from which market values are elicited (Cummings et al. 1986). In this case, since the typical good was used as the basis for environmental improvements in the other nine packages, participants in the study may be viewing this product as having lower overall quality—a lower level of environmental attributes. While this can explain why the typical package decreased in value, it is not as clear why the single low and single high-level environmental packages also decreased in value. Some of the bids for these packages decreased significantly—the low and high-level reduction in odor packages, as well as, the low-level surface water impact package.

A more formal explanation for this effect could be that the participants' expectations of the product attributes were not being met. These participants could be modeled as having incomplete information and having environmental quality showing up in their bid functions. Prior to the forth round, the bids were impacted by appearance and market price, i.e., the bids of the second highest bidders. The participants had no specific information on environmental quality, but they may have had a prior or ex ante expectation. Once the environmental information was released in round four, the participants updated their prior information and changed their bids accordingly. For the products that changed significantly in value, the participants' prior expectations of environmental quality were not being met. Hence they changed their bids accordingly. This could explain why the products with lower level environmental impacts experienced a decrease in the value of the package of pork chops. For those products that did not change significantly, the ex ante expectation of embedded environmental attributes is being met.

Willingness-to-pay with a Known Basis

This section investigates the second definition of WTP when the basis for product comparison is known. If all the packages were perceived as visually identical in the third round, then the WTP measure can be calculated by subtracting the bid for the typical package in round four from the bid of the package with embedded environmental attributes from round four. But it was seen above that all packages were not perceived as having exactly identical physical attributes. Otherwise, the bids for the packages in round three would all be equal. This implies that the WTP with known basis needs to be adjusted for the perceived physical differences. To make this adjustment, the difference between the typical package in round three and the corresponding package with embedded environmental attributes in round three must be accounted for. This implies that this WTP measure could be defined mathematically as:

(8) $WTP_i = (p_{i4} - p_{14}) - (p_{i3} - p_{13})$ for $i \in EP$.

WTP_i represents the WTP measure with a known basis adjusted for perceived visual differences for the i-th package of pork chops with embedded environmental attributes. The bid for the typical product in round t is represented by p_{1t}, while p_{it} represents the i-th package of pork chops with embedded environmental attributes in round t. EP is the set of packages of pork chops that have embedded environmental attributes.

Table 4 provides information on the WTP measure with known basis. Except for the package with the high-level ground water impact, the WTP for embedded environmental attributes is increasing with both level and number of embedded environmental attributes. This would be expected if environmental attributes are desired attributes. The package that commanded the smallest premium, $0.13, was the package with the low-level of reduction in odor attribute. As expected, the package that commanded the highest premium, $1.46, was the triple attribute high-level environmental package. Unlike the previous definition, this definition indicates a positive WTP for every bundle of embedded environmental attributes.

Table 4: Willingness-to-Pay with Known Basis (All Participants)

Pork Chop Environmental Attributes (Level of Improvement over Typical)	**Average Bids($)** **Willingness-to-Pay with Known Basis**
No Particular Environmental Attributes (Typical)	Basis
Odor 30-40%	0.13 (1.55)
Odor 80-90%	**0.39** (5.21)[a]
Ground water 15-25%	**0.46** (6.10)[a]
Ground water 40-50%	**0.43** (5.07)[a]
Surface Water 15-25%	**0.35** (4.42)[a]
Surface Water 40-50%	**0.56** (6.40)[a]
Odor 80-90%/Ground Water 40-50%	**0.83** (8.58)[b]
Odor 80-90%/Surface Water 40-50%	**0.93** (9.22)[b]
Odor 80-90%/Ground Water 40-50%/Surface Water 40-50%	**1.46** (12.56)[c]

Note: The number in parenthesis is the t-statistic for the test of whether the average bid is different from zero. Those numbers in **bold** were significantly different from zero. Also, the letter indicates that by doing a pairwise comparison between the premiums for the products, there was no statistical difference between the means being compared at the five-percent level of significance.

Testing to see if these WTP values are strictly greater than zero, only the package with a low-level reduction of odor is not significantly different than zero at the five-percent significance level.[10] The rest of the packages are significantly greater than zero. Examining whether the premiums differed across attribute levels, it was found that at the five-percent level of significance, all of the premiums for the single attribute packages, excluding the package related to low-level odor reduction, were not statistically different. Utilizing this same test shows that the packages with double attributes are also not significantly different from each other. The premium for the triple attribute package was significantly different from all other packages.

Discussion

This paper demonstrated two ways of defining willingness-to-pay measures using a multiple-round second-price auction with differing information sets across bidding rounds. It was shown that when the premium is defined as the difference in bids across information sets, then participants in the study were willing to pay an average of $0.94 more for a two-pound package of pork chops with a high level and quantity of environmental attributes. Defining the WTP measure as the difference between the bid for a base product with no identified environmental attributes and the bid for a product with a high level and quantity of environmental attributes, where each of these bids are coming from within the same round of bidding, it was found that the participants in the study would be willing to pay an average of $1.46 over the base product as a premium for the environmental attributes. This gives a discrepancy of $0.52 as to what the premium is for the product with the environmental attributes. This implies that depending on how you define willingness-to-pay can give a very different view as to the level of the WTP even using the same general auction structure.

The premiums in Table 4, i.e., the second definition used, could be representative of the results from an auction like the ones done by Roosen et al. (1998), Shogren et al. (1994b), Fox et al. (1994) which endowed the participants with a product and asks what they would be willing to

[10] Note that this is a one sided t-test and has a critical value approximately equal to 1.65 for $n > 30$.

pay to switch to a new product with a particular set of attributes.[11] When defining the WTP measure in this fashion, these researchers have discounted the possibility that the premium coming from the bid may be due to a discounting of the endowed product. The evidence that this is possible is seen in Table 3 where the participants of the study decreased their WTP for the base product by an average of $0.52. Hence the average premium of $1.46 in Table 4 for the most environmental product may be misconstrued as to the level of value-added from producing an environmental good.

Summary and Conclusion

This paper defined two ways of examining consumers' willingness-to-pay for attributes from a second-price auction with multiple-round with varying information sets. It was shown that no matter which definition of willingness-to-pay you use, there is a significant premium to be made on producing a product with a high level and quantity of environmental attributes. Also demonstrated in this paper is that when examining willingness-to-pay measures from an auction setting, it is important to realize that the premium being received when you originally endow the participant with a base product is not necessarily a pure value-added measure. Instead, part or the entire premium received may come from a devaluation of the endowed product. Hence by endowing the participants with a product, the premiums found in Roosen et al. (1998), Shogren et al. (1994b), Fox et al. (1994) may not tell the whole story as to where that premium is coming from, i.e., value-added or devaluation of the endowed product.

[11] This is not to say that the experiment done for this study was conducted the same way these other authors conducted their studies. The authors' assertion of this paper is that comparing premiums within an information set using a base product of comparison is equivalent to endowing participants with a good and asking them how much they would be willing to pay to switch to another good.

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